

REMARKS/ARGUMENTS

In the Office action dated August 5, 2005, the Examiner withdrew the previous non-final rejection of all claims, and then non-finally rejected all claims under 35 U.S.C. § 103(a) as being unpatentable over U. S. Patent No. 4,495,218 of Azuma *et al.*

In the Specification, no changes.

In the Claims, claims 1, 9, and 16, all of the independent claims, have been amended to clarify that the silicon nitride layer of the method of the invention is *grown* on the substrate, *vs. deposited* on a substrate, which is what has been done in every reference applied by the Examiner in every office action for this matter.

The Invention

The invention is a method of forming a high quality silicon nitride layer at low temperature in an integrated circuit. The method of the invention employs the use of nitrogen radicals to convert silicon to a silicon nitride, thus *growing* a silicon nitride thin film on a silicon-containing layer. The method of the invention may also form a thin nitride layer on an already-grown silicon oxide layer by displacing the oxygen at the top surface and converting at least a portion of silicon oxide to silicon nitride. The method of the invention does not use a plasma discharge, which may cause substantial damage to the silicon wafer. The method of the invention generates large quantities of nitrogen radicals on or near the surface of a silicon layer, or silicon oxide layer, which is to be converted to silicon nitride. The radicals are generated by the photolysis, or photo-dissociation, of NH₃. The light source used is a Xe₂ excimer lamp which emits at a wavelength of 172 nm, or 7.21eV in energy. The direct illumination of the wafer surface at such an energy level may generate photoelectrons and a charged surface that may

participate in the nitridation process. The work function of silicon is less than 5eV, so electrons can have over 2.2eV of kinetic energy. Electron attachment of the low energy electrons may generate negatively charged species, such as NH₂⁻, that are quite stable. Adsorbed molecules on the surface of the substrate may also play a role in the nitride layer growth. The growth of the film may be assisted by a field across the growing dielectric layer where a positively charged interface attracts negative ions.

The Applied Art

The Examiner has applied a single reference under 35 U.S.C. § 103(a): U. S. Patent No. 4,495,218 of Azuma *et al.* for *Process for forming thin film*, granted January 22, 1985. The '218 patent teaches that a thin film may be deposited on a substrate by introduction of the components of the final thin film in gaseous form into a CVD chamber.

The Claims

The independent claims have been amended, in an attempt to further prosecution of this case, to recite that the silicon nitride thin film of the method of the invention is *grown* on the substrate. Those of ordinary skill in the art will appreciate that there is a difference between depositing a layer of material and growing a layer of material: the method of the invention grows the silicon nitride layer from a combination of gaseous nitrogen and silicon present on the substrate. Whether the silicon on the substrate is in pure form or part of a silicon oxide layer is irrelevant to the method of the invention. '218 teaches, in the portions applied by the Examiner, col. 3, lines 11-39, that silicon is introduced into a CVD chamber in the form of a silane compound in gaseous form, and that the '218 method of the invention may be used to deposit a layer of a-silicon, silicon oxide or silicon nitride by thermal and plasma CVD methods. Applicant

specifically teaches away from plasma CVD because such process actually damages the silicon layer, Specification, page 3, lines 15-18.

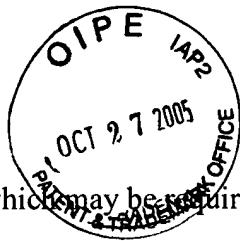
Claims 1, 9 and 16 are allowable over the applied art because the applied art does not teach or suggest formation of a silicon nitride layer wherein the silicon of the silicon nitride layer is obtained from a silicon-containing substrate; the '218 reference, like all of the other applied references in the long history of this Application, teaches that silicon is introduced into a CVD chamber in gaseous form with a nitrogen-containing gas, which results in deposition of a silicon nitride layer. This is not what Applicant teach or claims.

The remaining dependent claims are allowable with their allowable parent claims.

In light of the foregoing amendment and remarks, the Examiner is respectfully requested to reconsider the rejections and objections stated in the Office action, and pass the application to allowance. If the Examiner has any questions regarding the amendment or remarks, the Examiner is invited to contact the undersigned.

Provisional Request for Extension of time in Which to Respond

Should this response be deemed to be untimely, Applicants hereby request an extension of time under 37 C.F.R. § 1.136. The Commissioner is hereby authorized to charge any



additional fees which may be required, or credit any over-payment to Account No. 22-0258

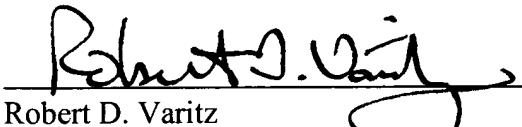
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Respectfully Submitted,

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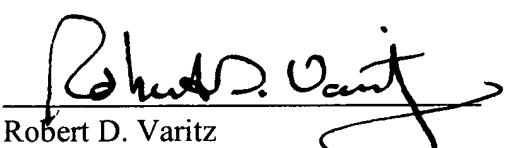

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I hereby certify that the attached RESPONSE TO OFFICE ACTION UNDER 37 C.F.R. § 1.111, and a Change of Correspondence Address and Associate Power of Attorney are being deposited with the United States Postal Service “Express Mail Post Office to Addressee” service under 37 C.F.R. 1.10 on the date indicated above and is addressed to:

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450


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